FORM PTO-1390 REV. 2/01T — U.S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 03715 0112

U.S APPLICATION NO. (If known, see 37CFR1 5): 10/070903

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FR00/02524	September 13, 2000	September 14, 1999

TITLE OF INVENTION
RADIOLOGY DEVICE COMPRISING IMPROVED IMAGE ENLARGING MEANS

APPLICANT(S) FOR DO/EO/US
Peter CHOI

Applicant(s) herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U S.C 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c)(2)).
   - a. ☐ is attached hereto (required only if not communicated by the International Bureau.
   - b. ☒ has been communicated by the International Bureau.
   - c. ☐ is not required, as the application was filed with the United States Receiving Office (RO/US)
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)).
   - a. ☒ is attached hereto.
   - b. ☐ has been previously submitted under 35 U.S.C. 154 (d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)).
   - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ have been communicated by the International Bureau.
   - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☒ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5))

Items 11 to 20 below concern document(s) or information included:

11. ☐ Information Disclosure Statement under 37 CFR 1.97 and 1.98
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3 31 is included.
13. ☐ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A Substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter 2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154 (d)(4).
19. ☐ A second copy of the English language translation of the international application 35 U.S.C. 154 (d)(4).
20. ☒ Other items or information:
   - a. ☒ Copy of cover page of International Publication No WO 01/19250
   - b. ☐ Copy of Notification of Missing Requirements.
   - c. ☒ Verification of Translation, (2 sheets); one for the application, and one for the annexes

10/070903 .021402

JC10 Rec'd PCT/PTO 13 MAR 2002

U.S. APPLICATION NO (If known, see 37CFR 1.5) 10/070903	INTERNATIONAL APPLICATION NO. PCT/FR00/02524	ATTORNEY'S DOCKET NUMBER 03715 0112

21. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**

International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**

International preliminary examination fee (37 CFR 1.482) paid to USPTOand all claims satisfied provisions of PCT Article 33 (1)-(4) **$100.00**

CALCULATIONS PTO USE ONLY

ENTER APPROPRIATE BASIC FEE AMOUNT =	$890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	$	

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE		
Total Claims	18	- 20 =		x $18.00	$	
Independent Claims	1	-3 =		x $84 00	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+$280.00	$280.00	
TOTAL OF THE ABOVE CALCULATIONS =					$1170.00	
☒ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.					$585.00	
SUBTOTAL =					$585.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest priority date (37 CFR 1.492(f)).					$	
TOTAL NATIONAL FEE =						
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property. +					$	
TOTAL FEES ENCLOSED =					$585.00	
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a. ☒ A check in the amount of $ 585 00 to cover the above fees is enclosed.

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P.
1300 I Street, N.W.
Washington, D.C. 20005-3315

DATED: March 13, 2002

SIGNATURE

Ernest F. Chapman Reg. No. 25,961

NAME/REGISTRATION NO.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. :

U.S. National Serial No. :

Filed :

PCT International Application No. : PCT/FR00/02524

VERIFICATION OF A TRANSLATION

I, the below named translator, hereby declare that:

My name and post office address are as stated below;

That I am knowledgeable in the French language in which the below identified international application was filed, and that, to the best of my knowledge and belief, the English translation of the international application No. PCT/FR00/02524 is a true and complete translation of the above identified international application as filed.

I hereby declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the patent application issued thereon.

Date: March 6, 2002

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3/PRTS

RADIOLOGY DEVICE COMPRISING IMPROVED IMAGE ENLARGING MEANS

The present invention relates in a general manner to medical radiology devices. More precisely, the invention relates to a device making it possible to obtain high-resolution digital images of organs or of tissues which one wishes to examine (which for the sake of simplicity will be referred to subsequently in this text by the generic term "subject"), as well as of any desired region of the subject.

Radiology devices which implement an X-ray source and a module making it possible to visualize the track of the X-rays having passed through the subject have been known and employed widely for many years. The following overall typology can be established for these devices:

- radiography devices, in which the subject is interposed between an X-ray source and an X-ray sensitive film. This type of device which was historically the first to be used and which is the most widespread, thus provides static images of the subject which must remain immobile during exposure thereof to the X-rays for a time sufficient to obtain an impression of the film by the X-rays. This type of device has rendered great service; it nevertheless has drawbacks, the main ones of which are the following:
  - limitation to the production of static images, thus precluding visualization of the dynamic evolution of the subject in order to characterize certain aspects of its functioning,
  - repeated exposure of radiologists to X-rays and health risk stemming therefrom,
- fluoroscopy devices on the other hand offer access to dynamic images. In these devices, the subject is interposed between an X-ray source and visualization means which in real time convert the

X-radiation into a visible image. These means may thus offer:

- ✓ direct visualization. In this case, the radiologist directly visualizes the "primary" images which are the first images formed by the visualization means from the X-rays. The visualization means then consist of a converter of the phosphor coating screen type.
- ✓ or indirect visualization. In this case, the device comprises means for acquiring the primary images at the output of a converter (the latter possibly being of the phosphor screen type), via a chain which may include a video camera filming the entire field of an output screen of the converter so as to form a "secondary" image, means for digitizing the image and means for processing, storing and distributing the images to various terminals (which may be on different sites).

In both cases (direct and indirect visualization), the visualization means allow dynamic viewing of the temporal evolution of the subject (visualization of the functioning of moving organs), thereby constituting an advantage and offering enhanced possibilities of implementation (recording of sequences illustrating the functioning of the subject, live operative assistance, etc.).

These fluoroscopy devices also have drawbacks however, among them being inferior image quality to that of radiography images (especially in terms of contrast), because of the necessary reduction in the intensity of X-ray emission for reasons of safety of the radiologist (and of the patients), the exposure to the radiation being lengthy.

To attempt to diminish the importance of this problem related to fluoroscopy devices, manufacturers have

implemented intensifiers which make it possible to convert the X-radiation into an optical image with high efficiency (that is to say by producing a high number of photons per incident X-ray).

By increasing the intensity of the images produced and by thus improving their contrast and their sharpness, these devices make it possible to lower the intensity of the X-radiation to a level below that implemented in radioscopy; they can function in direct or indirect visualization mode. In both cases, the intensifiers comprise an output interface for displaying the primary images to an observer, or transmitting them to an image acquisition chain.

The fluoroscopy devices thus constitute an advantageous means of carrying out good-quality radiological examinations. It is moreover possible to carry out the examination of the subject according to two types of procedures:

- based solely on images covering a single field containing the zone(s) of interest,
- or else by taking successive snapshots of different zones of interest.

The second type of procedure offers the advantage of greater flexibility of use, making it possible initially to take a wide-field snapshot so as to identify zones of interest, then to center the device successively on each of these zones.

For this type of use, especially in indirect fluoroscopy, image acquisition and enlargement means are generally provided for gathering the primary images as a whole, and then carrying out an enlargement of a part of the primary image centered on the desired zone.

However, this last type of use has the drawback of degrading the resolution of the secondary images which

will be visualized, given that the secondary images which are enlarged have previously been discretized by the acquisition means: the resolution of the image observed is in this case N times lower than the resolution of the acquisition means, N being the enlargement coefficient.

Moreover, in the case of intensifier devices, the resolution of the primary image is already greatly limited by the resolution of the intensifier itself, which is commonly of the order of from 1 to 2 pairs of lines per millimeter only.

Such a drawback can result in the impossibility of detecting certain details of very small size, such as for example certain early symptoms of cancer of the stomach which are of millimeter size.

Furthermore, the intensifiers of fluoroscopy devices generally comprise curved input screens which produce aberrations in certain parts of the image.

An aim of the invention is to alleviate the drawbacks mentioned hereinabove and to make it possible, on the one hand to construct a radiology device providing high-resolution images of any desired part of a subject, and on the other hand to implement such a device according to an advantageous process.

Another aim of the invention is to make it possible to construct a real-time radiology device in which inter alia the images are almost undeformed.

In order to achieve these aims, the invention proposes, according to a first aspect, a radiology device comprising an X-ray source for exposing a subject to the radiation of said source, means for converting the X-rays into optical images so as to form primary optical images, means for transforming the primary

optical images into secondary optical images, means for digitizing the secondary images and means for displaying the secondary images to a user, characterized in that the means for forming the secondary optical images comprise an optical chain comprising in succession, from the output of the converter to the output of the device, an image enlargement assembly exposed directly to the primary images from said conversion means, an assembly for optical intensification of the enlarged images and a photosensitive matrix sensor for making said secondary images.

Preferred, but nonlimiting aspects of the device according to the invention are the following:

- the enlargement assembly is a variable enlargement assembly, able to enlarge the images according to a desired enlargement coefficient within a given range.
- the enlargement assembly is made up solely of optical elements performing no discretization of the images.
- the device comprises means for moving the elements of the optical chain in a plane generally parallel to the midplane of the conversion means.
- the device comprises a central control unit for controlling the movement of the elements of the optical chain.
- the central control unit is physically distanced from the other elements of the device.
- the device comprises means of monitoring the exposure and the degree of enlargement of the images.
- the assembly for optical intensification of the images comprises components of the MCP type.
- the device comprises means for digitizing the secondary images arising from the photosensitive matrix sensor.

- the device comprises interfaces for distributing the images destined for digital peripherals.
- the device comprises a screen for visualizing the digitized secondary images.
- the means for converting the X-rays into optical images consist of a fluoroscopy screen of the phosphor coating screen type.
- said optical chain is directed along a different axis from the normal to the midplane of the means for converting the X-rays into optical images, the device comprises a mirror for deflecting the primary images to the optical chain and the device comprises a shield for protecting the elements of the optical chain from the X-rays.
- the optical chain comprises a refocusing lens.
- the device comprises a mirror for separating the images arising from the intensification assembly and a digital video camera.
- the optical coupling between the intensification assembly and the sensor is effected by optical fibers.

According to a second aspect, the invention also pertains to the use of one of the embodiments of the device described hereinabove, for real-time radiological examinations (especially for applications in the industrial and maritime sectors).

Other characteristics, aims and advantages of the invention will become more clearly apparent on reading the following description of three embodiments of the invention, given with reference to the appended drawings, in which:

- figures 1 to 3 are representations of the block diagram type of three embodiments of a radiology device according to the invention,
- figure 4 is a schematic representation of image acquisition elements which can be implemented in a radiology device according to the invention.

With reference firstly to Figure 1, there has been schematically represented a first module 10 comprising an X-ray source 11, and a fluorescent screen 12. This module 10 can be a conventional fluoroscopy module, the screen 12 delivering as output from the module 10 a primary visible image corresponding to the track of the X-rays emitted by the source 11 after they have passed through a subject S interposed between the source 11 and the screen 12.

The device also comprises a second module, referenced 20, for acquiring the primary images and for forming secondary images. As will be seen in greater detail subsequently in this text, the spatial coverage of these secondary images can correspond to that of the primary images formed on the fluorescent screen 12, or else to only a part of these primary images.

The module 20 comprises in a lightproof enclosure:

- an optical assembly 22 for variable enlargement of images, which is focused on the fluorescent screen 12,
- an image intensifier assembly 23 for producing, from the images enlarged by the assembly 22, images of greater luminous intensity,
- a refocusing lens 24 for reforming intensified images at the output of the assembly 23,
- an optical sensor 25, on which the lens 24 is focused, for gathering the enlarged and intensified image and for converting it into a discretized analog secondary image. This sensor can be a CCD type matrix for example.

The optical elements 22, 23, 24 and 25 of the module 20, which are assembled in series and thus form an optical chain, are furthermore mounted on a two-axis movement system which is not represented in the figures. This system can move these optical elements in the two directions coplanar to the fluorescent screen

12 so as to bring in particular the enlargement assembly 22 opposite any desired zone of this screen.

The device comprises a third module 30 for processing and distributing the images arising from the module 20. This module 30, which constitutes a central control unit for the device, comprises in the embodiment represented in Figure 1 the following elements which are interlinked:

- a unit 31 comprising electronic means for digitizing analog signals delivered by the sensor 25, and for processing these signals,
- a unit 32 for the local storage of digital images,
- an interface unit 33 for communicating video signals (originating from the sensor 25 and/or destined for external video peripherals),
- an interface unit 34 for communicating digital signals,
- and an exposure and enlargement control unit 36.

The module 30 also comprises means (not represented in the figure) for controlling the system for moving the elements of the optical chain of the module 20, in particular of the enlargement assembly 22.

The device finally comprises an interface 40 for local visualization of images which can consist of a high-resolution video screen hooked up to the units of the module 30. This interface 40 can be a digital screen receiving the secondary images digitized by the unit 31 of the module 30.

This device can function according to a continuous mode, likewise the subject of the invention, described hereinbelow:
The subject having been exposed to the radiations of the source 11 so as to form a dynamic image on the screen 12, the radiologist can visualize in real time on the screen 40 a secondary image corresponding to the

entire primary image formed on the screen 12, covering for example a widened field of the subject inside which the radiologist is searching for specific zones of study.

By virtue of the means of control of the movement system of the module 30 and by virtue of the exposure and enlargement control unit 35, the radiologist can then control the continuous movement of the optical chain formed by the elements 22, 23, 24 and 25 in a plane parallel to the plane of the screen 12, as well as the degree of enlargement of the image formed at the output of the lens 22 and transmitted to the other optical elements of the chain. This degree of enlargement can be fixed by the radiologist at any desired value within a given range, which depends on the choice of the assembly 22.

It will be noted that all or some of the elements of the module 30 may be situated some distance from the other constituents of the device (in particular from the modules 10 and 20), for example in a separate room dedicated to the control of the device and to the visualization of the images, or even in a separate building. In this case, the length of the link between the module 30 and the module 20 (which consists of at least one cable for transmitting the images from the optical sensor 25 to the module 30, and for transmitting the commands arising from the module 30 to the elements of the optical chain of the module 20) is suitably adapted.

To control these movement, exposure and enlargement means, the radiologist is provided with an interface (not represented) which can be associated with the visualization screen 40. This interface can use a control cable, linked to the module 30 to manually activate the image selection and capture process.

The screen 40 can be of any known type, inter alia a liquid crystal screen. The module 30 can also be associated with a PC type control computer supplemented with the commands of the device (commands for exposure, for moving the optical chain and for enlargement, etc.). Such a PC can contain a program for using the device, implementing a menu for the control of the device which is displayed on the screen 40 in combination with the output images from the device.

It is important to note here that according to the invention the resolution of the image is in no way altered by modifying the degree of enlargement, given that the assembly 22 which is composed solely of optical elements does not carry out any discretization of the image.

On the basis of images having a widened field, it is thus possible for the radiologist to identify zones of specific interest, then to move the optical elements and to zoom in on the chosen zone(s), while obtaining at the output of the assembly 22 an image whose resolution is in no way altered.

It will be noted that according to the invention, the chaining together of the snapshots of various zones with various degrees of enlargement is carried out in a continuous manner, this being an advantage in terms of ease of use.

The image (enlarged or otherwise) is transmitted by the assembly 22 to the optical intensifier 23, which will preferably be made up of so-called channel multiplier plate (or MCP according to the acronym in use) elements. An exemplary embodiment of such an element will be found in US patent 3 660 668. It is also possible to link several intensifier elements of the MCP type in series, and thus to obtain an optical gain of the order of 10^3 to 10^7.

By virtue of the optical intensifier 23, the intensity of the radiation of the X-ray source 11 is limit has a level equivalent has that conventionally implemented in intensifier fluoroscopy devices, that is to say the lengthy exposure of the radiologist and of the subject to radiation does not present a health risk.

It will be noted furthermore that an optical intensifier constructed from elements of the MCP type does not include elements of domed geometry such as the input screen of image intensifiers which is conventionally employed the fluoroscopy devices.

This constitutes an advantage insofar as this characteristic does not introduce any distortion of the image. The enlargement assembly 22 is thus the only optical element of the device comprising curved parts, so that the optical aberrations and deformations of certain zones of the image are reduced to the minimum.

The radiologist can thus carry out a continuous examination of various zones of the subject, by moving the optical chain formed by the elements 22, 23, 24 and 25 and by controlling via the unit 35 the enlargement of the image on each desired zone in succession, the enlargement of the image not altering the spatial resolution of the image.

It will be noted that the enlargement of the image is furthermore continuously adjustable by way of the control unit 35, thereby further increasing the flexibility of use of the device according to the invention.

A unit for programming successive movements and enlargements can also be integrated into the module 30 in order to undertake a program of predetermined examinations.

The assembly 22 can also be physically detached from the other elements 23, 24, 25 of the optical chain of the module 20, and it is also possible to control only the moving of this assembly 22 opposite the fluorescent screen 12, image transmission means such as an optical fiber link then being provided between the assembly 22 and the intensifier 23.

It should also be noted that the radiological examination process described hereinabove can be conducted without changing the intensity of the X-radiation to which the subject is exposed. Indeed, since the enlarging of the image does not alter its resolution, it is not necessary to increase the dose of radiation in order to visualize a zone of detail of restricted dimension.

The digital images can be stored by the unit 32 and distributed to any type of digital peripheral (or analog peripheral by virtue of the video signals communication interface unit 33). These peripherals may be visualization screens, high-resolution printers, remote means of storage and archiving, etc. They may be located on the same site as the device described above, or be situated remotely on other sites furnished with a link with the module 30.

By virtue of the device described hereinabove, the radiologist can also take a first fast snapshot of a widened field containing the entire subject, then study the image produced at his/her leisure, the source 11 being inactivated. After having identified the specific zones which he/she wishes to study in greater detail, the radiologist can then reactivate the source 11 to obtain detailed images of these zones with the full resolution of the assembly of sensors 25. This mode of use of the invention makes it possible to further reduce the level of exposure of the radiologist and of

the subject to radiation.

The module 30 can also comprise, in particular in the unit 31, all the known means for digitally processing the image, such as means for manipulating the image (choosing zones, rotation, processing of contrast and thresholding operations, etc.).

It will be noted that the resolution of the images produced by the device according to the invention is very markedly greater than that of the images produced by the fluoroscopy device implementing image intensifiers. The resolution of the images of these devices is in fact limited by the resolution of the intensifiers, which is at best of the order of from 1 to 2 pairs of lines per millimeter; the use of intensifiers of the MCP type, combined with the absence of discretization of the images during their enlargement, makes it possible to achieve a greater resolution.

It will furthermore be noted that by virtue of the means of processing and of distribution of the digital image of the module 30, the device according to the invention offers multiple possibilities of practical utilization. The files of the images may in fact be easily transmitted by electronic means to other sites so as, for example, to solicit the opinions of different experts.

It will also be noted that the use of printers, or of any other type of known peripheral for registering and/or printing on a medium such as paper (conventional or of photographic quality depending on requirements) the digital images arising from the module 30, constitutes an extremely flexible and economical means of obtaining negatives equivalent to radiographic negatives, so that the device according to the invention can be used as a radiography or fluoroscopy

apparatus.

Figure 2 represents a second embodiment of the device according to the invention in which the module 20 is folded at 90°, the image from the fluorescent screen 12 being deflected to the optical chain of the lens 22 by way of a deflecting mirror 26.

In this embodiment, the optical chain of the module 20 is oriented generally parallel to the plane of the screen 12, a 90° deflecting mirror 26 deflecting the images from the screen 12 to the enlargement assembly 22. A "T"-shaped shield 27 is also provided in order to protect the elements of the optical chain from the X-radiation.

Figure 3 presents a third embodiment of the invention in which between the image intensifier and the refocusing lens 24 there has furthermore been interposed a prismatic mirror 28 for separating the image, so as to separate the images transmitted by the optical intensifier into two beams directed respectively towards the sensor 25 and towards a digital video camera 29, these two elements being linked to the unit 31 of the module 30.

This third embodiment allows separate acquisition of dynamic images (by the camera 29) and of static images (by the sensor 25); this arrangement makes it possible to further increase the flexibility and the performance of the device.

Figure 4 represents a variant embodiment of elements of the optical chain of the device according to the invention, in which the image intensifier 23 is linked to the sensor 25 by a network of optical fibers 24' in replacement for the refocusing lens 24.

Of course, the device according to the invention is not

limited to the embodiments described hereinabove, but may be embodied according to any variant within the scope of the person skilled in the art.

The use of such a device is not limited to the medical sector; the device described hereinabove can in fact also be implemented in any other sector of application of radiography apparatuses, and of X-ray examination in general.

In particular, the use of such a device for the inspection or nondestructive qualitative analysis of materials, for example in the industrial sector (inspection of walls or of pipelines, etc.), maritime sector (inspection of ships or of submarines, etc.), etc., makes it possible to access the advantages of real-time flexibility of use described hereinabove with regard to medical examination.

CLAIMS

1. A radiology device comprising an X-ray source (11) for exposing a subject (S) to the radiation of said source, means (12) for converting the X-rays into optical images so as to form primary optical images, means (20) for transforming the primary optical images into secondary optical images, and means (40) for displaying the secondary images to a user, characterized in that the means for forming the secondary optical images comprise an optical chain comprising in succession, from the output of the converter to the output of the device, an image enlargement assembly (22) exposed directly to the primary images from said conversion means (12), an assembly (23) for optical intensification of the enlarged images and a photosensitive matrix sensor (25) for making said secondary images.

2. The radiology device as claimed in claim 1, characterized in that the enlargement assembly (22) is a variable enlargement assembly (22), able to enlarge the images according to a desired enlargement coefficient within a given range.

3. The radiology device as claimed in claim 1 or 2, characterized in that the enlargement assembly (22) is made up solely of optical elements performing no discretization of the images.

4. The radiology device as claimed in one of the preceding claims, characterized in that it comprises means for moving the elements of the optical chain in a plane generally parallel to the midplane of the conversion means.

5. The radiology device as claimed in the preceding claim, characterized in that it comprises a central control unit (30) for controlling the movement of the

elements of the optical chain.

6. The radiology device as claimed in the preceding claim, characterized in that the central control unit is physically distanced from the other elements of the device.

7. The radiology device as claimed in one of the preceding claims, characterized in that it comprises means of monitoring the exposure and the degree of enlargement of the images.

8. The radiology device as claimed in one of the preceding claims, characterized in that the assembly (23) for optical intensification of the images comprises components of the MCP type.

9. The radiology device as claimed in one of the preceding claims, characterized in that it comprises means (31) for digitizing the secondary images arising from the photosensitive matrix sensor.

10. The radiology device as claimed in the preceding claim, characterized in that it comprises interfaces for distributing the images destined for digital peripherals.

11. The radiology device as claimed in one of the preceding claims, characterized in that it comprises a screen for visualizing the digitized secondary images.

12. The radiology device as claimed in one of the preceding claims, characterized in that the means (12) for converting the X-rays into optical images consist of a fluoroscopy screen of the phosphor coating screen type.

13. The radiology device as claimed in one of the preceding claims, characterized in that said optical

chain is directed along a different axis from the normal to the midplane of the means (12) for converting the X-rays into optical images, the device comprises a mirror for deflecting the primary images to the optical chain and the device comprises a shield (27) for protecting the elements of the optical chain from the X-rays.

14. The radiology device as claimed in one of the preceding claims, characterized in that the optical chain comprises a refocusing lens (24).

15. The radiology device as claimed in one of the preceding claims, characterized in that it comprises a mirror (28) for separating the images arising from the intensification assembly (23) and a digital video camera (29).

16. The radiology device as claimed in one of the preceding claims, characterized in that the optical coupling between the intensification assembly (23) and the sensor (25) is effected by optical fibers (24').

17. The use of a radiology device as claimed in one of the preceding claims for real-time medical examination.

18. The use of a radiology device as claimed in one of claims 1 to 16 for nondestructive qualitative inspection of materials, in particular in the industrial or maritime sector.

(12) DEMANDE INTERNATIONALE PUBLIÉE EN VERTU DU TRAITÉ DE COOPÉRATION EN MATIÈRE DE BREVETS (PCT)

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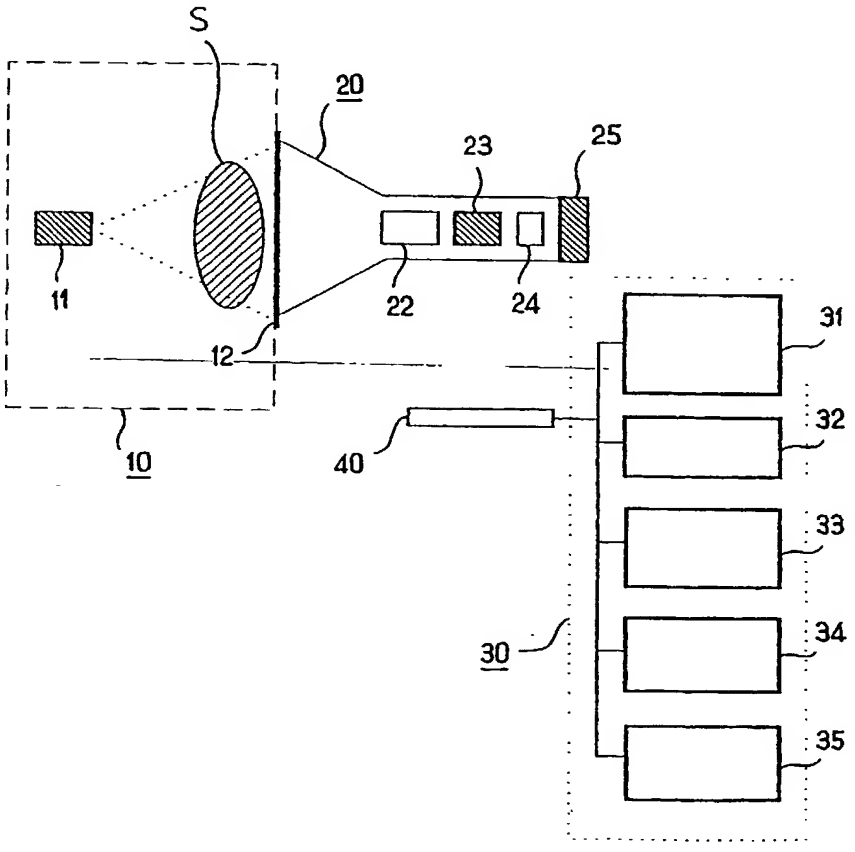
[Suite sur la page suivante]

(54) Title: RADIOLOGY DEVICE COMPRISING IMPROVED IMAGE ENLARGING MEANS

(54) Titre: DISPOSITIF DE RADIOLOGIE COMPORTANT DES MOYENS D'AGRANDISSEMENT D'IMAGES PERFECTIONNEES



(57) Abstract: The invention concerns a radiology device comprising an X-ray source (11) for exposing a subject (S) to the radiation of said source, means (12) converting the X-rays into optical images for forming primary optical images, means (20) for transforming the primary optical images into secondary optical images, and means (40) for displaying the secondary images to a user. The invention is characterised in that the means forming secondary images comprise an optical chain including a succession, from the converter output towards the device output, an image enlarging assembly (22) directly exposed to the primary images of said converting means (12), an assembly (23) for optical intensification of the enlarged images and a photosensitive matrix sensor (25) for forming said secondary images.

[Suite sur la page suivante]

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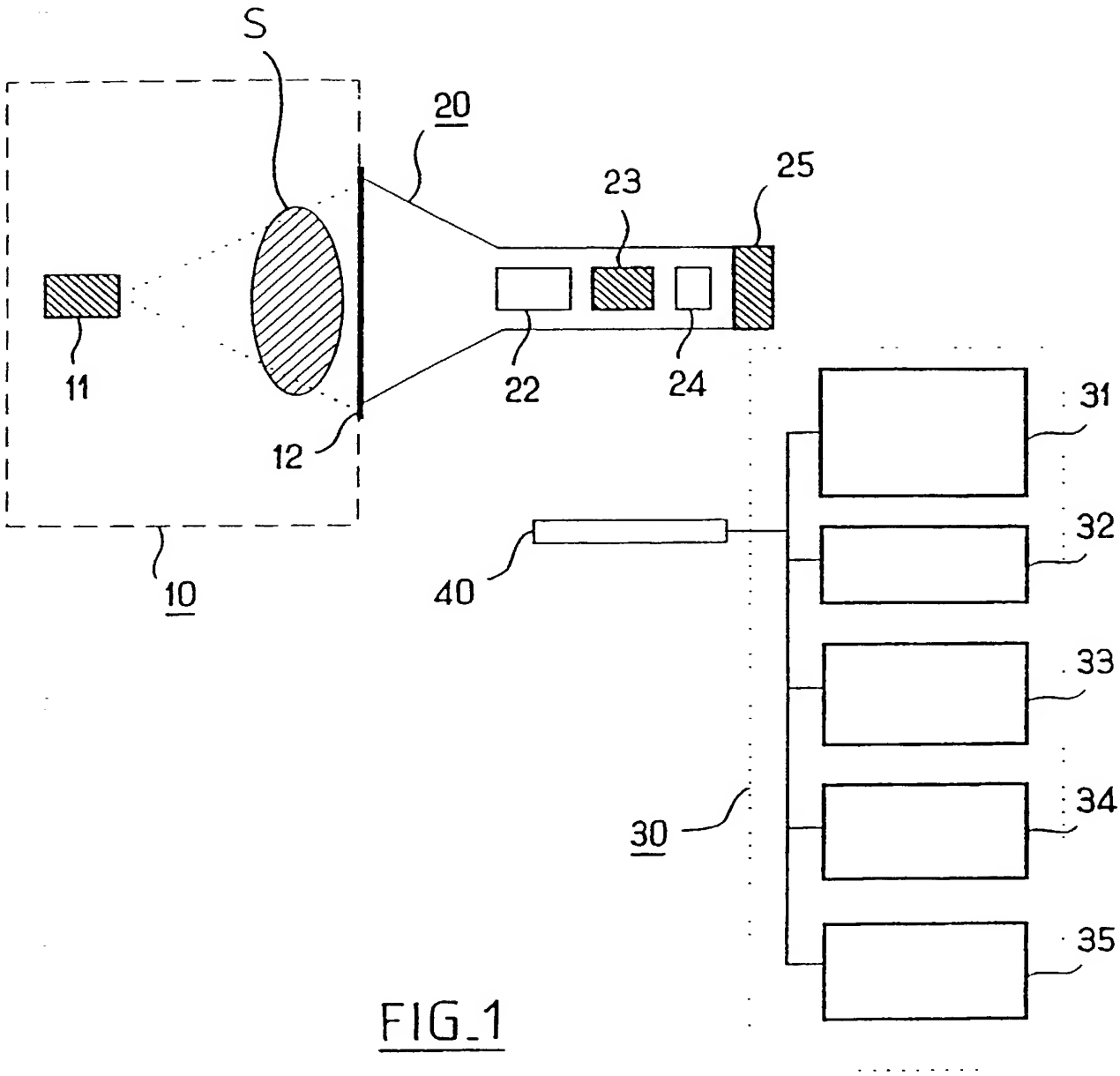

FIG_1

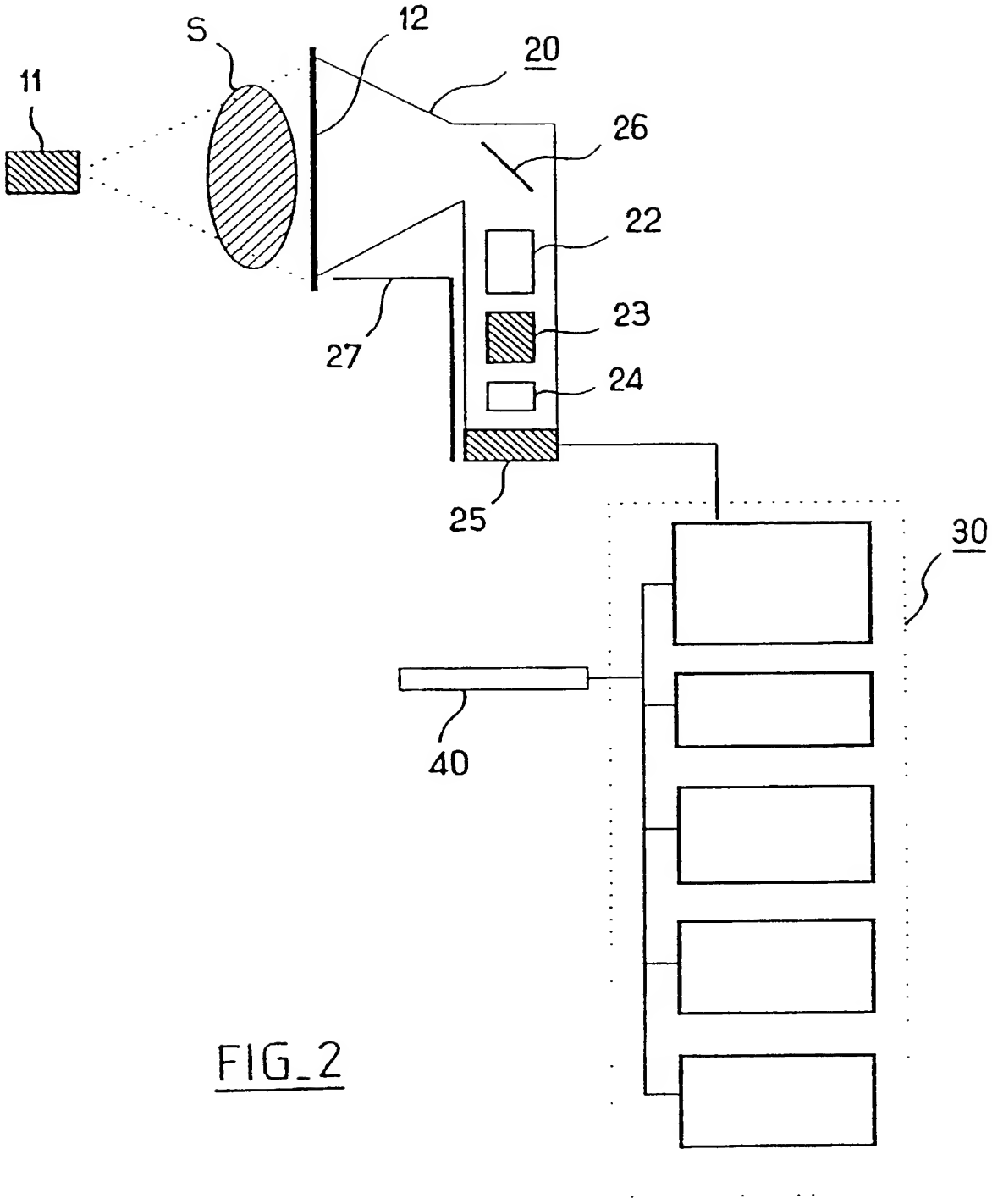

FIG_2

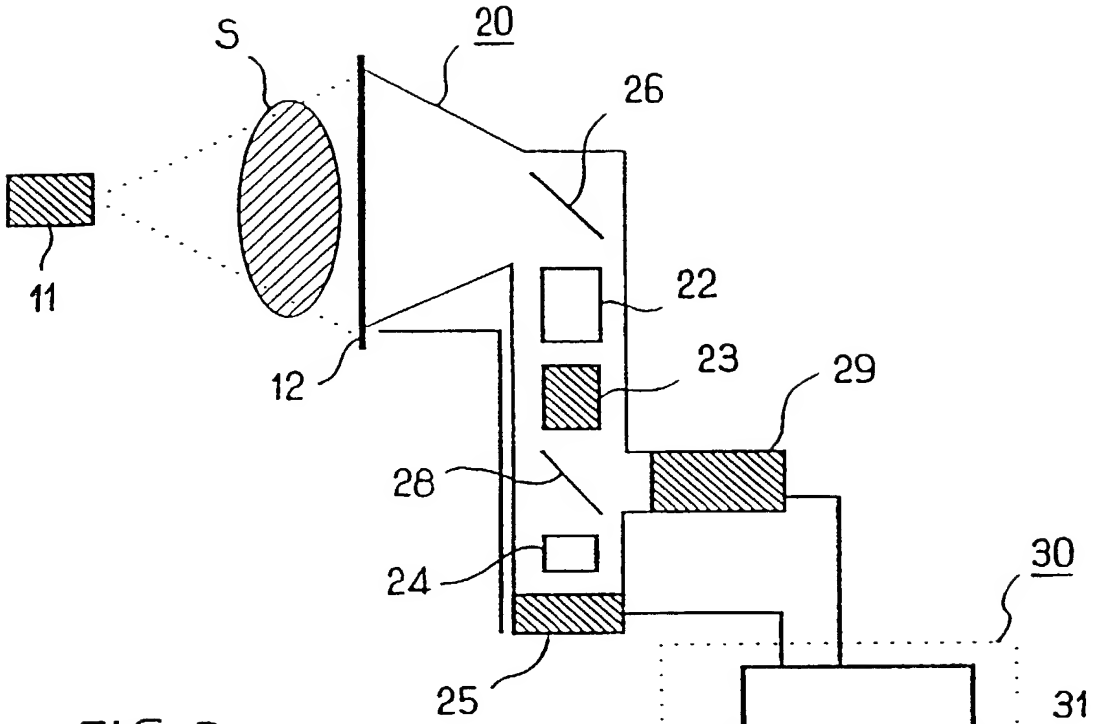

FIG_3

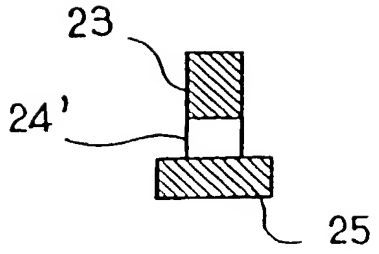

FIG_4

Attorney Docket No: [illegible]

#4

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: "Radiology device comprising improved image enlarging means"
the specification of which θ is attached and/or θ was filed on as United States Application Serial No. or PCT International Application No. FR99/ and was amended on (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate or § 365(a) of any PCT International application(s) designating at least one country other than the United States, listed below and have also identified below, any foreign application(s) for patent or inventor's certificate, or any PCT International application(s) having a filing date before that of the application(s) of which priority is claimed:

Country	Application Number	Date of Filing	Priority Claimed Under 35 U.S.C. 119	
FRANCE	9911469	September 14, 1999	θ YES	θ NO
			θ YES	θ NO

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

Application Number	Date of Filing

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT International application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application(s) in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application(s) and the national or PCT International filing date of this application:

Application Number	Date of Filing	Status (Patented, Pending, Abandoned)
PCT/FR00/02524	September 13, 2000	Pending

(62)

I hereby appoint the following attorney and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER L.L.P.**, Douglas B. Henderson, Reg. No. 20,291; Ford F. Farabow, Jr., Reg. No. 20,630; Arthur S. Garrett, Reg. No. 20,338; Donald R. Dunner, Reg. No. 19,073; Brian G. Brunsvold, Reg. No. 22,593; Tipton D. Jennings, IV, Reg. No. 20,645; Jerry D. Voight, Reg. No. 23,020; Laurence R. Hefter, Reg. No. 20,827; Kenneth E. Payne, Reg. No. 23,098; Herbert H. Mintz, Reg. No. 26,691; C. Larry O'Rourke, Reg. No. 26,014; Albert J. Santorelli, Reg. No. 22,610; Michael C. Elmer, Reg. No. 25,857; Richard H. Smith, Reg. No. 20,609; Stephen L. Peterson, Reg. No. 26,325; John M. Romary, Reg. No. 26,331, Bruce C. Zotter, Reg. No. 27,680; Dennis P. O'Reilley, Reg. No. 27,932; Allen M. Sokal, Reg. No. 26,695; Robert D. Bajefsky, Reg. No. 25,387; Richard L. Stroup, Reg. No. 28,478; David W. Hill, Reg. No. 28,220; Thomas L. Irving, Reg. No. 28,619; Charles E. Lipsey, Reg. No. 28,165; Thomas W. Winland, Reg. No. 27,605; Basil J. Lewris, Reg. No. 28,818; Martin I. Fuchs, Reg. No. 28,508; E. Robert Yoches, Reg. No. 30,120; Barry W. Graham; Reg. No. 29,924; Susan Haberman Griffen, Reg. No. 30,907; Richard B. Racine, Reg. No. 30,415; Thomas H. Jenkins, Reg. No. 30,857; Robert E. Converse, Jr., Reg. No. 27,432; Clair X. Mullen, Jr., Reg. No. 20,348; Christopher P. Foley, Reg. No. 31,354; John C. Paul, Reg. No. 30,413; Roger D. Taylor, Reg. No. 28,992; David M. Kelley, Reg. No. 30,953; Kenneth J. Meyers, Reg. No. 25,146; Carol P. Einaudi, Reg. No. 32,220; Walter Y. Boyd, Jr., Reg. No. 31,738; Steven M. Anzalone, Reg. No. 32,095; Jean B. Fordis, Reg. No. 32,984; Barbara C. McCurdy, Reg. No. 32,120; James K. Hammond, Reg. No. 31,964; Richard V. Burgujian, Reg. No. 31,744; Michael Jakes, Reg. No. 32,824; Dirk D. Thomas, Reg. No. 32,600; Thomas W. Banks, Reg. No. 32,719; Christopher P. Isaac, Reg. No. 32,616; Bryan C. Diner, Reg. No. 32,409; M. Paul Barker, Reg. No. 32,013; Andrew Chanho Sonu, Reg. No. 33,457; David S. Forman, Reg. No. 33,694; Vincent P. Kovalick, Reg. No. 32,867; James W. Edmondson, Reg. No. 33,871; Michael R. McGurk, Reg. No. 32,045; Joann M. Neth, Reg. No. 36,363; Gerson S. Panitch, Reg. No. 33,751; Cheri M. Taylor, Reg. No. 33,216; Charles E. Van Horn, Reg. No. 40,266; and Linda A. Wadler, Reg. No. 33,218; and . Please address all correspondence to FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, L.L.P. 1300 I Street, N.W. Washington, D.C. 2005, Telephone No. (202) 408-4000.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1-00

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